BABAR January-February 2006 Newsletter
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1. Status of PEP-II

The 8 weeks since the Collaboration meeting have been used by PEP-II to continue delivery of integrated luminosity, while diagnosing two very-difficult transient LER instability problems. As you know, the *B* Factory and *BABAR* ran straight through the holiday break for the first time this year, in what proved to be a smooth and successful operation. I would like to thank the physicists, shift crews and support staff of PEP-II and the Linac for their tremendous dedication in making *B* Factory operation over the holiday such a success.

As a result of extended running, the integrated luminosity for Run 5b now stands at 18.5 fb^{-1}. This is about 10 fb^{-1} less than our goal at this point, largely because the peak luminosity is lower than planned. Intense investigations of two LER instability problems have been the focus for the *B* Factory team. However, because of the transitory nature of the problems, the underlying sources have proven very difficult to diagnose and localize. The instabilities have limited LER currents in recent running to the range 1350-1700 mA, with corresponding reductions for HER current, peak luminosity, and ultimately integrated luminosity. The first problem is a fast transverse instability in the LER, followed by an abort due to lost current, which we believe was due to two dislodged rf gap rings in IR-4. The second problem is due to vacuum bursts in the IR-2 region from an unresolved source, which causes aborts due to background in the forward-east SVT diodes.

Fast transverse LER blowup problem

The LER transverse blowup phenomenon was already described by Uli Wienands in his plenary talk on PEP-II status at the December meeting. Throughout the first half of December, the LER was seen suddenly to develop a vertical instability accompanied by transverse beam blowup within about 50 turns. The transverse feedback system was able to damp the core motion, but the beam blowup resulted in beam abort within about 500 turns due to the current loss rate. The threshold for this problem varied between 1600 and 2500 mA, depending on the set up of the machine. Enormous energy was focused on identifying the source of this problem throughout December and early January, including engaging many machine experts from outside PEP-II. Considerable attention was given to the transverse feedback system, although the core of the beam was properly stabilized after the onset of each event.

On January 7th, a breakthrough came when a one-to-one correlation was observed between vacuum bursts on a gauge in the region of LER rf cavity 4-2 and the onset of these transverse instability events. During a subsequent extensive ROD (Jan 17-23), two rf gap rings were discovered to be displaced and projecting into the vacuum region (Figure 1). One had clearly been arcing as a result, with copper deposited on nearby

surfaces. The gap rings have been replaced and the vacuum bursts have not been observed since. We are confident that the displaced rings are the source of the LER transverse blowup problem, although LER currents have not been restored to the 2000-2500 mA range to demonstrate definitively that this is the case, for reasons described below.

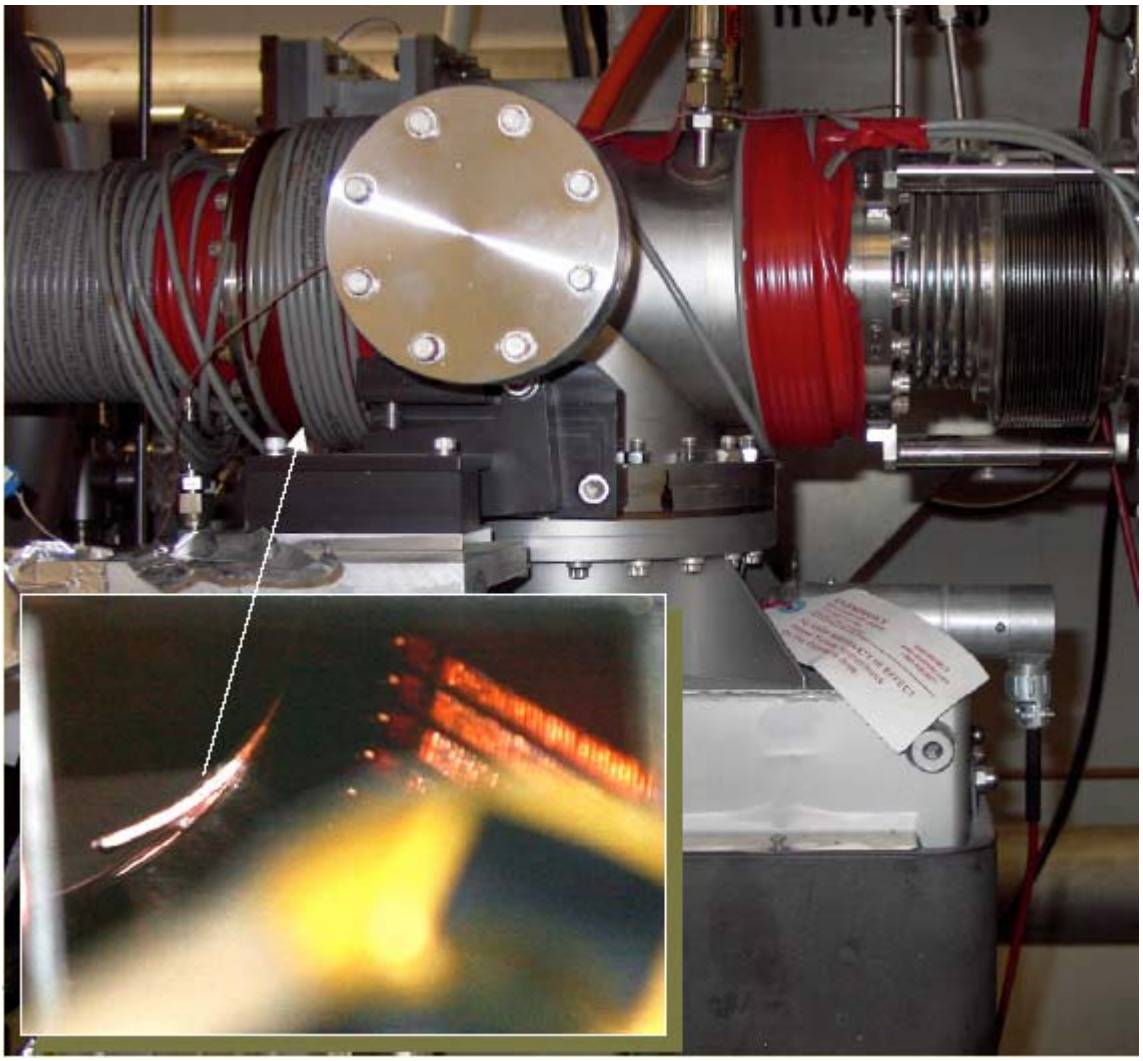

Figure 1. *LER vacuum system in the region of the 4-2 rf cavity, showing the location of the displaced rf gap ring. The inset shows a view inside the vacuum pipe, where the displaced rf gap ring and source of arcing can be seen to project into the vacuum region.*

IR-2 vacuum burst problem

Shortly after the December meeting a second problem began to appear in the form of transient vacuum bursts in the IR-2 region, where a brief increase in pressure by as much as 500-1000 nTorr is observed over a period of 10's of seconds. While the burst is seen with varying amplitude in gauges and pumps around IR-2, the largest increase is seen in a pump and gauge (designated as 3027 in Figure 2) at the interface between Q4 and Q5 on the LER inbound beamline. Gauges across the IP in the LER outbound beamline (2187)

see about 10 times smaller spike, while the HER sees about 100 times less activity (7083 and 8020). For the detector, the burst is large enough to produce significant background activity in the forward east SVT diode (sensitive to backgrounds produced by the LER inbound beam), which in turn is sufficient to cause a fast abort of the LER beam. The current threshold for these vacuum bursts began at around 1800 mA, but gradually reduced over the holiday running to about 1350 mA.

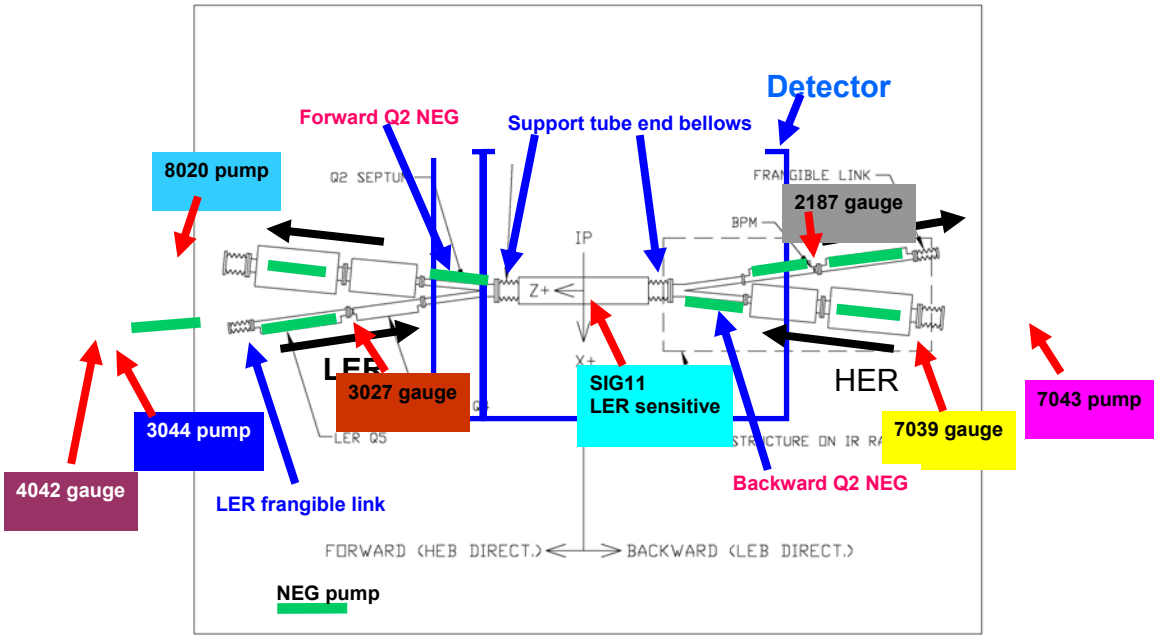

Figure 2. *Schematic drawing of the IR-2 vacuum system, showing the locations of pumps and gauges that are available to diagnose the source of observed vacuum bursts. The locations of NEG pumps are also indicated.*

The mechanism for the vacuum bursts is not yet identified. It could be internal arcing due to HOM absorption or it could be an external leak that opens up with sufficient thermal expansion due to HOM heating. In either instance, the localized burst of gas quickly propagates outward from its source and is seen in multiple gauges and pumps around the IR. The amplitude and the rise time of the pulse depend on the profile of the vacuum system between the instrument and the source, as well as any pumping that exists in between. Both the transient nature of the bursts and the complicated vacuum system in the IR region make it difficult to identify the source.

During the first half of January, a long list of experiments was conducted to try to determine the nature and localize the source of the vacuum bursts. While these studies did not pinpoint a location, they continued to suggest the LER inbound beamline as the source, with suspicion centering on the complicated Q2/Q1 bellows with its rows of HOM absorber tiles. As a result, it was decided to break vacuum in IR-2 to allow visual inspection of the vacuum system with a borescope, along with simultaneous investigation of the vacuum leak in the vicinity of the 4-2 rf cavity described above. Work began on January 17 and extended until January 23. Visual inspection of the Q1/Q2 forward bellows revealed no observable problems. Likewise, inspection of the beryllium bellows

close to the IP showed no problem. The Q2/Q4 rf seal showed curious surface imperfections (Figure 3), but after removal and replacement this proved to be a superficial problem. Borescope inspection of the rear Q1/Q2 bellows shows 5 fingers of the rf omega seal are not properly seated. No evidence for arcing was seen around the displaced fingers, but with somewhat limited visual access. Since this bellows has been in this condition since installation in 2002, is not in a location consistent with the vacuum burst evidence and would take at least a week to replace, it was decided to leave it as is, close vacuum and resume operation. In the end, a large portion of the inbound and outbound LER beamline and outbound HER was examined by borescope. After scrubbing vacuum and resolving a number of coincident hardware failures (including a quadrupole ground fault induced by ground water leak in the PEP-II tunnel), beams were restored on January 26. Unfortunately, shortly afterwards the IR-2 vacuum bursts reappeared.

Figure 3. *Borescope picture of the Q2/Q4 rf seal, showing different surface reflectivity at different azimuthal locations. After removing the seal, the surface differences were found to be a cosmetic difference in the surface coating and not the result of internal arcing.*

Further tests are now continuing, with the aim of localizing the source of the problem. The most definitive of these is a series of experiments with heating the Q2 and Q5 NEG pumps to cause them to outgas. By this means one could experimentally determine the response of pumps and gauges around IR-2 to controlled release of gas. Tests were conducted with and without beam. Comparing the pattern in the control experiments with the pattern observed in the actually vacuum bursts causing beam aborts strongly suggested the Q4/Q5 LER inbound beamline region as the source, which is also consistent with the observed response of the SVT diodes. Measurements in this region showed that an ion pump/TSP pump plenum at the Q4/Q5 boundary and the location of the vacuum gauge with the highest excursions in pressure had significant HOM mode power, despite rf screening and absorber tiles designed to shield the region. To eliminate

this assembly as a possible source for the vacuum bursts, the plenum was removed on February 2, with beam collisions restored on February 4 after NEG pump regeneration and modest scrubbing. Unfortunately, vacuum bursts were observed shortly afterwards, although at somewhat higher LER currents than before the intervention (1750 vs 1350 mA).

BABAR analysis of time-development of vacuum and abort diode signals

Assuming the vacuum bursts start out caused by a local leak or arc, the gas produced diffuses outward with an effective linear velocity along the pipe in the range of 10-20 m/s. Vacuum gauge data for several burst events have been made available to *BABAR* physicists, with a recording of the time development at 1 ms intervals. Howard Nicolson has used the different rise and fall times of signals from pumps on the forward and backward sides of the detector to attempt to locate the source. Brian Petersen has also noted that peak of the signal in the forward east abort diode is offset in time from the forward west diode by about 25 ms. The forward east diode is uniformly sensitive to LER backgrounds due to raised vacuum pressure anywhere from -0.4 to -9.5 m from the IP. On the other hand the forward west diode mainly sees gas from LER bremsstrahlung striking the vacuum chamber wall between -1.2 and -1.6 m from the IP. As a result, the peak response time difference may be usable to localize the source, again making assumptions about effective diffusion velocities for the vacuum burst. Both studies are encouraging beginnings of a method to locate the source, but will benefit enormously from a more precise understanding of the vacuum model and, in particular, propagation velocities for transient bursts. In this connection, I should point out that these studies also show that there are plenty of opportunities for *BABAR* physicists to engage in data analysis tasks that will directly improve our ability to help PEP-II deliver luminosity.

Present plans for resolving IR-2 vacuum problem

A number of ongoing experiments designed to localize the vacuum burst problem will continue. These include systematic search for leaks using helium flow outside the LER inbound vacuum system from Q5 to Q2 and a residual gas analyzer at the Q4/Q5 boundary to determine if there is an external leak. We are also now prepared to introduce controlled amounts of nitrogen either upstream of Q5 or eventually at the Q4/Q5 interface to allow a more precise calibration of the vacuum model and eventually a localization of the source from timing and rise time measurements in the vacuum gauges and SVT abort diodes.

In parallel, temporary replacements for the Q4 and Q5 chambers are under construction. These should be available for installation by about February 21, if the evidence continues to point to this region as the source of the problem. We may in the meantime decide to further strip out components of the existing chambers, such as the NEG pumps in Q5 and/or the HOM absorber in Q4. The forward Q2 chamber was scheduled to be replaced in the PEP-II upgrades this coming fall. The assembly is fairly advanced already and will be accelerated so that the Q2 chamber could be replaced in about 4 weeks, should this prove necessary.

Clearly the IR-2 transient gas bursts are a difficult problem to localize and even more difficult to repair because of the congested nature of this region and the unique design of many components. Nevertheless, we are working hard to resolve the problem as quickly as possible. If you want some challenging data mining problems and want to help us get back to high luminosity, please get in touch with Bill Wisniewski or myself.

Conclusions from PEP-II Machine Advisory Committee meeting

In the midst of all the near-term challenges of resolving the LER vacuum problems, the PEP-II Machine Advisory Committee met from January 18-20. After reviewing progress on all fronts, the committee strongly endorsed the plans for reaching 2×10^{34} and 1 ab^{-1} integrated luminosity, which they viewed as having a high probability of success. They also had a number of important recommendations, most notably the desirability of a more focused effort on achieving a high quality and usable optics model of the machine, the need for a workable Q/Q2 shielded bellows solution, and the need to mitigate the component lifetime effects of frequent high-current beam aborts. SLAC is already moving to respond to these suggestions, for example, by strengthening the optics model team where I would anticipate much progress over the coming months.

2. Status of BABAR

BABAR has continued to operate with high efficiency since the start of Run 5b. Again, I would like to commend the shift crews over the holiday period, who continued to operate the experiment in an efficient manner. This burden fell disproportionately on the local residents, and especially the SLAC group, who I would particularly like to thank for their dedication in stepping into the breach.

One operational problem that has become more common over the last few weeks is the loss of the trickle signal from PEP-II, which is used to mark and reject a timing window around the injected bunch. It is thought that the signal loss is related to heavy loading of the PEP-II micro involved. We are moving shortly to activate a redundant pathway for the trickle injection signal to ensure the integrity of the data.

The DCH readout upgrade continues to make excellent progress towards activation. In particular, a shift of test data was recorded on February 7 with the feature extraction code activated in the FPGA on the DCH endplate rather than in the ROM. A first look at the test data shows no problems, so we anticipate moving to the much smaller DCH readout payload in the near future. The rate of DCH electronics upsets appears to be at a level consistent with predictions based on the estimated neutron flux and code is in place to identify most upset events and automatically reconfigure.

3. Status of P-5 review

My understanding is the P-5 the recommendations for the *B* Factory and Tevatron programs and the full report are final but not yet publicly available. Formally, P-5 is a

subcommittee of HEPAP, which in turn is a federal advisory body with a fairly exhaustive process for appointment of members and a chair. As a result of delays in these appointments, HEPAP will not meet next until March 3-4. Therefore, the P-5 report on the *B* Factory and Tevatron will not be public until sometime shortly thereafter. My understanding is that the recommendations remain as described in my opening talk at the December meeting.

The next task for P-5 is to build a full roadmap of ongoing operating facilities and experiments, and new initiatives. There will be a new round of P-5 meetings, including a visit to SLAC that is tentatively scheduled for April 20-21. This visit will include an update on the *B* Factory and *BABAR*, although the main focus will be on other parts of the particle physics program.

In the meantime, Robin Staffin commented quite positively about DOE's plans for the *B* Factory, stating to the other funding agency representatives at the recent *BABAR* International Finance Committee that the intention was to run to the end of FY2008, assuming the available budget. More comments on prospects for improved budgets are provided in the next section.

4. FY07 budget and funding outlook

On February 6, the Presidential budget request for US FY2007 was released. The budget request reflects the goal, announced by President Bush in the State-of-the-Union address on January 31, of doubling the budgets for critical basic sciences research programs in the physical sciences over the next 10 years (7%/year). Consistent with this goal, Secretary of Energy Samuel Bodman announced on February 2 that the FY2007 budget includes a $4.1 billion request for the Department of Energy's Office of Science. This represents a $505 million (14.1%) increase over FY2006 funding. At the level of the Office of High Energy Physics the planned increase is $58.4 million, with $30 million of this going to ILC. SLAC's budget will be substantially increased as well, both through an extra $10 million in BES funding for linac operations as well as a yet to be determined portion of the extra ILC funding. As Jonathan has noted, the budget request must now be ratified by Congress and there may well be some adjustments. However the Administration's commitment to doubling the DOE's science budget in the next ten years is exceptional news, especially in the light of limited growth in the past ten years.

You may find the following links useful:

Secretary Bodman's press release on the DOE budget request for FY07:
http://energy.gov/news/3150.htm

Undersecretary Orbach's press release on DOE Office of Science request for FY07:
http://www.science.doe.gov/Sub/Newsroom/News_Releases/DOE-SC/2006/budget/2-6%20-%20Master%20FY%2007%20final.pdf

5. Shifts and service work commitments

We are continuing to experience considerable difficulty in filling *BABAR* shifts during Run 5b. This is quite disturbing, given the broad institutional commitment to continuing the experiment until the end of FY2008. In order to reach our goal of 1 ab^{-1}, we will need to maintain an ongoing highly efficient operation, from data taking to reconstruction and skimming. We are in discussion with the Executive Board about alternative shift schemes, along the lines of what was suggested by Bill Wisniewski in his opening plenary session talk at the December meeting. In the meantime, please do your part by examining the shift quota for your institution and signing up if you are falling behind in fulfilling your obligations in this area. You can find the shift quota status page at:

http://www.slac.stanford.edu/babar-internal/shiftstat/list.html

Action Item: Please take a look at your institution's quota for 2006 and do your part by signing up for shifts in the near future.

As already noted, you should be planning as well on roughly 30% of your institutions FTE effort being devoted to service tasks. There are plenty of opportunities in this area as well, so I recommend that you check the internal advertisements available at:

http://www.slac.stanford.edu/BFROOT/www/Physics/ServiceTasks/ServiceTasks.html

6. Physics opportunities and upcoming deadlines

As a reminder, the work to accumulate a substantially enlarged data sample has as its underlying goal the pursuit of a broad and exciting physics program. If you are not currently working on a physics topic, there are plenty of opportunities available on the list of undermanned projects located at:

http://www.slac.stanford.edu/BFROOT/www/Physics/Analysis/undermanned.html

You should consult Riccardo Faccini or Jim Olsen about the details of these projects or other opportunities. Now that CM2 is fully implemented and the suite of physics tools continues to expand, it has never been easier to do an analysis on *BABAR*.

For those who are planning to complete an analysis in time for the winter 2006 conference season, please take note of upcoming deadlines for internal review and documentation located at:

http://www.slac.stanford.edu/BFROOT/www/Physics/Planning2006/conf.PDF

Based on planning for the Winter Conferences, we are expecting about 50 collaboration-wide talks and release of the corresponding new results over the coming weeks. If you are involved with developing or reviewing one of these analyses, please keep in mind that *BABAR* speakers are already lined up to include these new and exciting results at

upcoming conferences. The priority in all cases is not just release of the new results, but also the completion and submission of the corresponding journal article. In this connection, I would like to recommend that you attend practice talks for the winter conferences if you have the opportunity. Please consult the schedule at:

http://www.slac.stanford.edu/BFROOT/www/Organization/Speaker/practice-agenda.html

7. February Collaboration Meeting

As a reminder, the February Collaboration meeting will run from Tuesday, February 21 to Saturday, February 25. We will begin the first session on Tuesday at 8:15am PT (note the early start time), which means that the Saturday sessions will run through 12:00 noon PT. We will hold the Executive Board meeting early on the Saturday morning, while the Technical Board will meet after the close of the main collaboration meeting at 1:00pm, for those who are involved in these meetings. Also, the Collaboration Council meeting will be held somewhat early this time around on Tuesday evening. Please find the draft agenda on the web at:

http://www.slac.stanford.edu/BFROOT/www/Organization/CollabMtgs/2006/detFeb06/Feb2006Agenda.pdf